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Eliminating unwanted electron in EBIS devices*

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In principle, an electron beam ion source (EBIS) device has a very simple mode of operation: an electron beam propagating through a gated ion trap step-wise ionizing trapped ions to high charge states. The electron beam, which is confined by an extremely large magnetic field, is injected from an electron gun through the trap into an electron collector. The ions are confined by the electron beam space charge radially and by high voltage electrodes (gates) axially. Unlike earlier EBIS devices, where the Debye length was larger than the radial dimension of trap plasma, the RHIC EBIS Debye length meets requirements needed for plasma theories to be valid in its analysis. Any instability requires a free source of energy to grow. Electrons stripped from ions can form a layer that slips past other particles in an EBIS trap, or accumulate in the gates. In either case, these electrons can be a source of free energy for diocotron instability by providing a slipping stream or a variety of microinstabilities due to axial positive slope gradients in configuration and velocity space. Possible solution to the problem is to remove these electrons from the trap. One option is to install an additional drift tube between the gate and the collector biased to higher Voltage than the other tubes, and bleed these electrons to ground in an additional split drift tube inserted upstream from the highest Voltage tube. Analysis of this idea will be presented.

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